

A Revision of Indian Mugilidae¹

PART I²

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(With four text-figures)

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INTRODUCTION

Workers on the grey mullets (Mugilidae) all over the world seem to have experienced considerable difficulty in distinguishing the different species of the family owing to the very close resemblance between them. This has led to a search for more reliable and distinctive characters for distinguishing the various species; and the generic revisions of the family by Schultz (1946) and Smith (1948) are notable contributions in this direction.

Little or no progress has been made in the study of the taxonomy of the Indian species of the family Mugilidae since Day's comprehensive account, *FISHES OF INDIA* (Day, 1876-1888) and *FAUNA OF BRITISH INDIA, FISHES* (Day, 1889), although local species in various

¹ Communicated by Dr. H. Srinivasa Rao, F.A.S.C., F.N.I. Part of the thesis that formed the basis for the award of the degree of Doctor of Philosophy of the University of Madras.

² Genus *Mugil* Linnaeus, genus *Rhinomugil* Gill, and some 'doubtful species' will appear as Part II of this paper together with the complete list of references.

parts of the country have been studied by Whitehouse (1922) at Tuticorin, Pillay (1951) in Bengal, and Devasundaram (1951) in Chilka Lake. Some of the later workers have questioned the validity of certain species described in Day's publications. A detailed biometric comparison of samples of the Indian species, *Mugil dussumieri* Valenciennes and *M. persia* Hamilton, made by me (Sarojini, 1953) has shown that the two are synonymous. Following this interesting finding, it was considered desirable to re-examine the systematics of all the known Indian species of the family.

The present study is based mainly on the collections of mullets in the Zoological Survey of India which contain many of Day's original specimens. But fresh collections of mullets made by me in West Bengal, and those obtained from Visakhapatnam, through the courtesy of Dr. N. K. Panikkar, and from Ennore, Krusadai Island, and Cochin, through the courtesy of Dr. T. V. R. Pillay, were also available for study.

DISTINGUISHING CHARACTERS OF MUGILIDAE

Previous studies have shown that many of the characters considered to be of taxonomic value undergo marked changes with growth. Jacot (1920), Sarojini (1953), and Pillay (1954) have observed the absence of adipose eyelids in young stages (of *M. cephalus*, *M. persia*, and *M. tade* respectively) and their progressive development with the growth in size of the fish. Thompson (1954) also recognised this fact, though he has made use of this character to distinguish certain Australian genera and species of mullets.

Pillay (1954) has observed variation in the size of the eye of *M. tade* in relation to the size of the fish.

Jacot (1920) observed in *M. cephalus* that the cycloid scales of the young fish become ctenoid later. Pillay (1951) has corroborated the same in *M. cephalus*, *M. tade*, *M. persia* and *M. corsula*.

While Day (1878, 1889), Günther (1861), and Whitehouse (1922) have attributed considerable taxonomic importance to the size and shape of the uncovered chin space of mullets, I have found these to vary markedly with the growth of the fish.

The number of rays in the anal fin has also been used as a diagnostic character by many workers. Jacot (1920) found the first soft ray in the anal fin of the young *M. cephalus* gradually ossifying to become the third anal spine. A similar change with growth has

also been observed in *M. parsia* by me (Sarojini 1953, 1957) and in *M. tade* by Pillay (1954).

Day (1889), Whitehouse (1922), and others considered the mandibular angle to be of taxonomic importance in mullets. Weber & de Beaufort (1922) and Thompson (1954), however, found this angle varying with age in some species. The acute angle in the young of *M. cephalus* becomes gradually obtuse as the fish grows.

The length of the 3rd anal spine has also been used as a diagnostic feature by Day. But, as pointed out elsewhere (Sarojini, 1953), this cannot be relied upon, as with the growth of the fish the base of the fin gets more and more densely covered with fine scales which makes measurement of the length of the spine subject to bias.

A comparative study of the young and the adults of the Indian species of mullets has shown convincingly that the characters mentioned are of no taxonomic importance owing to their variability with the growth of the fish. A sound taxonomic key should enable the identification of both the young and the adult stages of each species. So these characters have not been used in the diagnosis of the species considered in this study. But where the characters attain a certain constancy of form after a particular stage in the growth of the fish, as seen in the scale characteristics, the number of anal rays, the presence of adipose thickenings around the eye, etc., they have been included in the descriptions.

Though Schultz (1946, 1953) and subsequently Smith (1948) and Thompson (1954) laid great stress on the nature of the dentition for distinguishing the genera of mullets, in the present study this character has been used only in the diagnosis of species. In some species, however, the structure of the teeth changes with the growth of the fish, having simple tips in young and bifid or even trifid in large adults (Schultz, 1946).

The dorsal profile of the mullets which has been considered a diagnostic character by Day (1878, 1889) and Weber & de Beaufort (1922) is greatly altered by the degree of distension or contraction of the body muscles after death and is, therefore, not considered in this study as a reliable distinguishing character.

Examination of fresh material of the available species has shown the relative height of body to be of some use as a specific character. But many of the preserved specimens in the Zoological Survey of India, the abdomen of which had been slit open for the purpose of preservation, had the cut edges of abdominal wall curled in and

could not be measured correctly for body height. So this could not be used as a diagnostic character in the present study.

Another diagnostic feature of somewhat limited application is the relative position of the anal and second dorsal fins. Its inter-specific variability consists of the proportion of the basal length of the anal in advance of the origin of the second dorsal, which usually ranges between $\frac{1}{4}$ and $\frac{2}{3}$. In actually measuring this, i.e. by dropping a vertical line from the point of origin of the second dorsal to meet the base of the anal and then measuring the distance from that point to the origin of the anal, there is a likelihood of much personal error occurring. Hence no stress has been laid on this character for diagnostic purpose.

Smith (1935) has suggested that the arrangement of the ventral fins and the inter-ventral flange may have some significance in specific or generic distinction. As many of the specimens in the Zoological Survey of India collections had been cut in this region for preservation it was not possible to examine its significance.

Measurements studied:

The measurements employed in this study for calculation of body proportions were taken with fine point dividers. Some of the measurements used, such as standard length, length of head, least height (depth) of caudal peduncle, and the distance from snout to anal were taken as defined by Pillay (1954) and some others, the forkal length, length of snout, height of body, distance from snout to 1st dorsal, snout to 2nd dorsal, and snout to the ventral, as taken by Thompson (1954). Hence these are not re-defined here. The various other measurements used here are defined below:

Total length—from the tip of the snout to the end of the longest ray of the ventral lobe of the caudal fin

Height of head—the maximum height between the dorsal and ventral aspects of the head taken just before the operculum bends upwards

Width of head—the maximum width of head, measured from cheek to cheek

Height of snout—measured just in front of the anterior rim of the orbit

Width of snout—measured just in front of the anterior rim of the orbit

Diameter of orbit—usually the distance between the anterior and posterior rims of the orbit. Where the orbit was not exactly circular, the diameter between the dorsal and ventral rims were also noted

Width of anterior adipose eyelid—from the anterior rim of orbit to the edge of the anterior eyelid

Width of posterior adipose eyelid—from the posterior rim of orbit to the edge of the posterior eyelid

Inter-orbital distance—measured across the head as the distance between the uppermost points on the dorsal rims of the orbits

Length of caudal peduncle—from the posterior edge of the base of anal fin to the end of hypurals

Height of 1st & 2nd spines of the 1st dorsal—from the base of the spines to their tip

Length of pectoral—from the point of origin of the pectoral fin to the tip of its longest ray

Morphological characters:

The following morphological characters were found to be of help in distinguishing the different genera and species of mullets:

1. The presence or absence of opercular spine
2. The presence or absence of folds and papillae on the upper lip
3. The position of the lips (terminal or ventral)
4. Nature of the serrations on the extremity of the pre-orbital
5. Nature of the symphysial knob
6. Exposed or concealed position of the end of maxilla when mouth is closed
7. Presence or absence of notch on the ventral aspect of the lower lip below the symphysial knob
8. The relative position of the pre-orbital
9. Presence or absence of pointed scale in axil of pectoral fin

FAMILY MUGILIDAE

Since the erection of the genus *Mugil* by Linnaeus in 1758, several workers have attempted to subdivide it; and there have been several generic revisions of the family. Of the numerous genera thus created, the genus *Liza* of Jordan & Swain (1884) was considered valid by Indian workers and some Indian species were assigned to this genus (Chaudhuri, 1917; Whitehouse, 1922; Hora, 1923; Herre, 1941, and Devasundaram, 1951). Recent workers in other countries (Smith, 1948; Herre, 1953, and Thompson, 1954) have also recognised this genus. The distinguishing character of *Liza* Jordan & Swain is the absence of adipose eyelids; but many of the species assigned to this genus do possess adipose eyelids, though their degree of development may be less than those of *Mugil*. Moreover, as pointed out

on page 255, the adipose eyelids are not evident in the young of most of the Mugilids, even though they may be well developed in the adults. Hence, as Roxas (1934) rightly pointed out, this genus cannot be considered valid, its revival by Oshima (1922) notwithstanding.

Schultz (1946) was the first to conduct a comprehensive study of the world genera of Mugilidae. He drew attention to the taxonomic importance of the mouth parts and other qualitative characters in the family, and defined 13 genera which he considered valid. Of these the genera under which certain Indian species have been placed, are *Rhinomugil* Gill, *Crenimugil* Schultz, *Mugil* Linnaeus, and *Chelon* Röse.

Rhinomugil Gill, has for its genotype *Mugil corsula* Hamilton, and the distinguishing characters of this genus are stable and distinct enough for it to be accepted as valid.

Crenimugil Schultz was erected to accommodate *Mugil crenilabis* Forskål. *Mugil labiosus* Valenciennes, which occurs in Indian waters also, has been assigned to this genus by Thompson (1954). But he had presumably not seen Schultz's recent contribution (Schultz, 1953) wherein he created a new genus, *Plicomugil*, to accommodate *Mugil labiosus* Valenciennes. The distinguishing characters of this new genus are stable and very distinct from those of *Crenimugil* Schultz, and are in complete agreement with the specimens of *Mugil labiosus* examined by me. *Plicomugil* Schultz, and not *Crenimugil* Schultz, is therefore accepted here as one of the valid Indian genera.

The characters of *Mugil* Linnaeus and *Chelon* Röse are, however, overlapping. The original descriptions of the genera, with *Mugil cephalus* Linnaeus and *Mugil chelo* Valenciennes respectively as genotypes, do not differ from each other in any significant details. Schultz (1946), who has elaborated on these genera, has also not laid down any clearly defined and stable differentiating characters for them. He has placed undue importance on certain characters, such as the presence or absence of adipose eyelids. There are also some vaguely defined characters in his descriptions, such as 'the pre-orbital is also bent posteriorly at a *more or less sharp angle*' in *Chelon*, while in *Mugil* 'the pre-orbital has the front edge *straight or nearly so*; maxillary *not notably exposed*'; 'upper lip *usually not so wide as distance between nostrils*'; 'teeth *probably present* on vomer . . . etc.': (the italics are mine). The differentiating characters of the two genera given by Schultz (1946, 1953) are tabulated below:

Mugil Linnaeus*Chelon* Röse

- | | |
|---|---|
| 1. Distance between nostrils wide, equal to or greater than width of upper lip (upper lip usually not so wide as distance between nostrils) | Upper lip wider than distance between nostrils |
| 2. Anterior and posterior nostrils widely separated, farther apart than anterior nostril is from groove that separates upper lip from rest of snout | Nostrils closer to each other than anterior is from groove behind upper lip |
| 3. Posterior edge of pre-orbital narrower than distance between nostrils, its posterior tip scarcely or not reaching past front of eye. Anterior edge straight or nearly so without a conspicuous concavity | Posterior edge of pre-orbital is wider than distance between nostrils. Anterior edge of pre-orbital concave or angular |
| 4. Maxillary and premaxillary not hooked downward, maxillary not notably exposed, both in line with front edge of pre-orbital | Maxillary with its posterior part notably exposed, sharply curved downward over posterior part of premaxillary and extending below pre-orbital a distance greater than width between nostrils. Premaxillary with its front margin sharply angular, non-dentate posterior portion hooked backward and downward almost at right angles to toothed portion |
| 5. Adipose eyelid well developed reaching to or nearly to pupil except in young | No adipose eyelid present |
| 6. No teeth on vomer or palatine | Villiform patches of teeth on vomer and palatines present or absent |
| 7. Teeth in certain species become bifid or trifid in very large sized adults | Teeth simple in young as well as large sized adults |

A close study of these characters will show that most of them are not distinct enough for a clear differentiation between the two genera. The only characters which show clearly marked difference are the relative position of the two nostrils and the shape of the maxillary bone. From the present study it is seen that these characters can be assigned only specific significance. *Mugil seheli* Forskål, which Schultz (1953) has assigned to *Chelon* Röse, in fact shows affinity, in the relative position of its nostrils, to *Mugil* Linnaeus rather than to the former. *Mugil parsia* Hamilton and *Mugil tade* Forskål show what may be called intermediate characteristics in that the

distance between the nostrils is equal to the distance of the posterior border of upper lip from the anterior nostril. At the same time the other characteristics of these species do not allow of inclusion in any other tenable genus of Mugilidae. Again, according to Schultz (1946, 1953) the maxillary in *Mugil* is not notably exposed, while in *Chelon* it is notably exposed. In *Mugil seheli* Forskål the maxillary is not exposed when the mouth is closed; yet Schultz (1953) has assigned it to the genus *Chelon*. In the shape of the maxillary bone, the different Indian species show varying degrees of intermediate characteristics between those laid down by Schultz (1946, 1953) for *Mugil* and *Chelon*. Besides, I am at variance with Schultz's (1946, 1953) statement that both *Mugil* and *Chelon* have cycloid scales. In fact, all the Indian species allotted to these genera by Schultz himself have cycloid scales in the young and ctenoid scales in the adult, the only exception being *Mugil seheli* Forskål (*Chelon seheli*, according to Schultz, 1953) which has cycloid scales when young as well as when grown to a large size. After a considered study of all the differentiating characters between *Mugil* Linnaeus and *Chelon* Röse as described by the original authors and by Schultz (1946, 1953) I am of opinion that the difference between the two, if any, cannot be given importance, at any rate as far as the Indian Mugilidae are concerned. *Chelon* Röse has, therefore, not been recognised here.¹

Whitley (1930) created genus *Ellochelon* with *Mugil vaiensis* Quoy & Gaimard as genotype, and subsequently Smith (1948) has recognised this genus. The distinguishing characters of the genus are 'the broad head, truncate caudal and dark fins'. These characters, as Schultz (1953) pointed out, are not sufficiently distinctive or stable to be bestowed generic importance. *Ellochelon* Whitley is, therefore, considered here as a synonym of *Mugil* Linnaeus.

Valamugil (Smith, 1948) has for its genotype *Mugil seheli* Forskål. The distinguishing characters given were: 'No adipose eyelids. Upper lip thin, no papillae, maxilla bent down over pre-maxilla, end concealed. Lower margin of pre-orbital concave. Anal starts about opposite 2nd dorsal.' Schultz (1953) contends that, since these characters are not in any way different or distinct from those attributed to *Chelon* Röse, genus *Valamugil* Smith should be considered a synonym of the former. I am in agreement with Schultz (1953)

¹ It has not been possible to examine the genotype of *Chelon* Röse, *Mugil chelon* Valenciennes of the Mediterranean. *Chelon* Röse has not, therefore, been brought here under the synonymy of *Mugil* Linnaeus.

that *Valamugil* Smith cannot be considered a tenable genus, and so have brought it under the synonymy of *Mugil* Linnaeus.

Liza Jordan & Swain and *Valamugil* Smith have been recognised by Thompson (1954) as valid genera; but, for the reasons already discussed, I am unable to agree with him in this respect.

Fowler (1939) erected the genus *Sicamugil* to accommodate *Mugil hamiltoni* Day. Schultz (1946, 1953) and Thompson (1954) did not consider this genus to be tenable and, therefore, assigned it to the synonymy of *Trachystoma* Ogilby. The present study showed *M. hamiltoni* Day and the closely allied species *M. cascasia* Hamilton to be different from all other known Mugilids in the possession of an opercular spine. So it becomes necessary to separate these two species under a distinct genus. *Sicamugil* Fowler is, therefore, removed from the synonymy of *Trachystoma* Ogilby and emended here to include this distinct character, namely the presence of an opercular spine. In Fowler's (1939) description of the genus he has laid emphasis on 'the strongly spinate pre-orbital, the head largely and completely covered with small scales, especially over its lower surfaces, absence of adipose eyelids and peculiar facies (*Sica*=dagger, with reference to the pre-orbital spine)'. He has not mentioned the presence of the opercular spine though it is seen in the figure given by him. I am of the opinion that this particular character, viz. the presence of an opercular spine, is of greater generic significance than the characters emphasised by Fowler. It may also be pointed out here that Fowler's (1939) figure appears to be somewhat exaggerated in regard to the pointed snout.

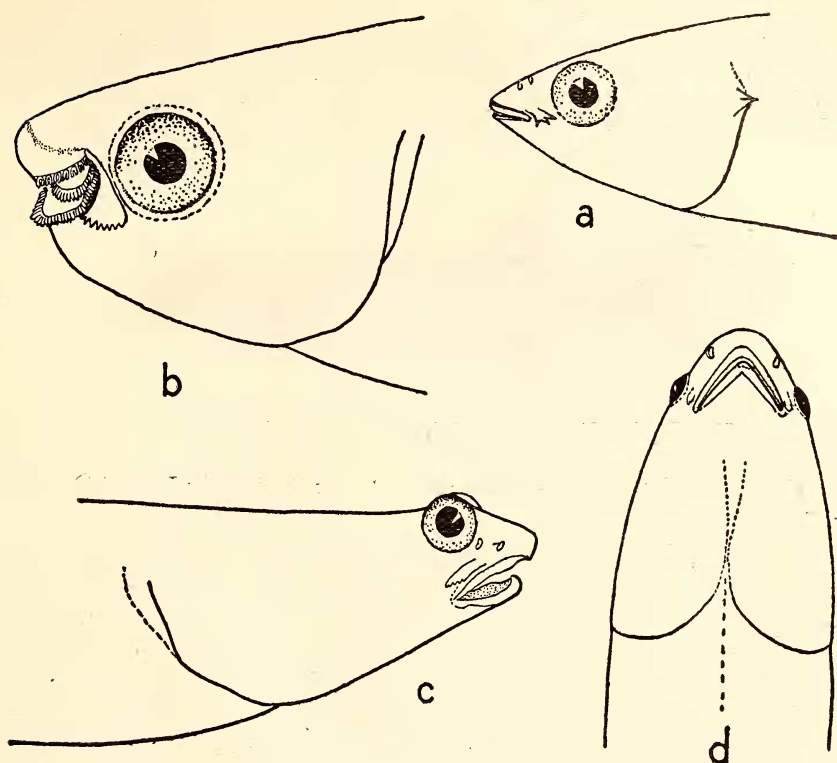
In view of the above discussion it is possible to recognise only four genera for the Indian species of grey mullets studied here.¹

These genera may be distinguished by the following key:

KEY TO THE INDIAN GENERA OF MUGILIDAE

- | | |
|---|------------------------------|
| 1. Opercle with a spine | .. <i>Sicamugil</i> Fowler |
| Opercle without spine | .. 2 |
| 2. Upper lip with paired fleshy papillate lobes | .. <i>Plicomugil</i> Schultz |
| Upper lip without paired fleshy papillate lobes | .. 3 |
| 3. Upper lip terminal of snout | .. <i>Mugil</i> Linnaeus |
| Upper lip ventral of snout | .. <i>Rhinomugil</i> Gill |

¹In her recent paper on the grey mullets of Kayamkulam Lake, John (1955) has recognised *Liza* and *Valamugil*. In view of the reasons laid down in the foregoing pages, I am unable to support her recognition of these genera.



Text-fig. 1.—(a) Lateral view of the head of *Sicamugil cascasia* showing the opercular spine and the tri-cuspid pre-orbital; (b) Lateral view of the head of *Plicomugil labiosus* showing the folded papillate lips; (c) Lateral view of the head of *Rhinomugil corsula* showing the overhanging snout and elevated eyes; (d) Ventral view of the head of *Rhinomugil corsula* showing the position of lips and mouth.

Genus *Sicamugil* Fowler

Sicamugil Fowler, *Notul. Nat. Acad. Philad.* 17, p.9, 1939 (genotype *Mugil hamiltoni* Day) (Rangoon, Burma).

An opercular spine present (Text-fig. 1). Lips terminal and without lobes or papillae. Nostrils in level with upper rim of orbit. Symphysial knob present. No distinct teeth on jaws. Anterior edge of pre-orbital without conspicuous notch and its extremity with a few well-developed spines. Mouth protrusible.

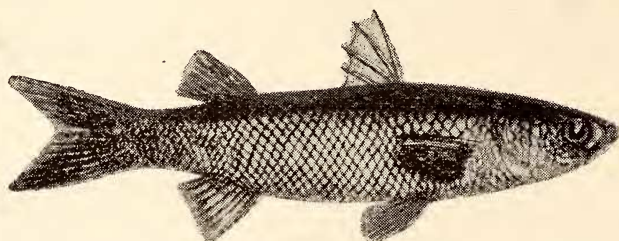
KEY TO THE INDIAN SPECIES OF GENUS *Sicamugil*

- | | |
|---|--|
| Extremity of pre-orbital distinctly tri-cuspid .. | <i>S. cascasia</i> (Hamilton) |
| Extremity of pre-orbital distinctly tetra-cuspid .. | <i>S. hamiltoni</i> (Day) ¹ |

¹ Though *S. hamiltoni* (Day) has not been recorded from Indian waters, a description of the species based on specimens in Day's collections in the Zoological Survey of India has been included in this paper.

Sicamugil cascasia (Hamilton)

Mugil cascasia Hamilton, *Fish. Ganges*, pp. 217-380, 1822; Cuvier & Valenciennes, *Hist. Nat. Poiss.*, 11, p. 145, 1836 (N. Bengal); Day, *Fish. India*, p. 355, pl. LXXV, fig. 6, 1878-1888 (Delhi); Fauna Brit. India, Fishes 2, p. 351, 1889 (upper waters of Jamuna and Ganga; also Indus and Brahmaputra).



Text-fig. 2. *Sicamugil cascasia* (Hamilton) (After Day, 1878)

D IV, 1 + 8; A. III + 8-9; V. I + 5; P. 14-15; L. 1. 36-39; L. tr. 16-18.

Length of head greater than height of body. Head higher than broad. Length of snout equal to or very slightly less than its own height, which is again less than its breadth. Diameter of orbit equal to or slightly greater than length of snout, and less than inter-orbital distance. Insertion of D_1 conspicuously nearer tip of snout than to base of caudal. Origin of pelvic fins nearer anal than to tip of snout. Length of caudal peduncle less than height of head and equal to or slightly less than width of head. The 1st spine of D_1 longer than the 2nd spine. Insertion of pectoral fin below middle of body. Caudal fork fairly deep.

Proportionate measurements: vide Appendix A.

Scales: 36-39 on the longitudinal series and 16-18 on the transverse. Pre-dorsal scales 16. No elongated scale in axil of pectoral. Bases of all fins except D_1 covered with minute scales. Scales of body strongly ctenoid.

Orientation of fins: Insertion of D_1 above 7th-8th, of D_2 above 22nd-24th, and of anal below 20th-22nd scales of the longitudinal series. Pelvic fin inserted below 4th-5th and reaches to the 11th-13th L.1. scales.

Teeth not present on jaws. Lips very thin. Upper lip forms tip of snout and part of dorsal profile. Pre-orbital bent and strongly serrated on the anterior and ventral aspects. The extremity is

distinctly tri-cuspid. Nostrils of unequal size, the posterior larger than the anterior. The distance of the posterior nostril to the orbit is less than that of the anterior to the upper lip, which in turn is slightly greater than the distance between the nostrils. Symphysial knob double. Adipose eyelid absent. End of maxilla hardly visible when mouth is closed. Opercle with one strong spine.

Colour: Bright yellow on sides. Dorsal and dorso-lateral parts of body streaked with black bands on the bright yellow background. Ventral aspect white and silvery. A large yellow blotch on base of caudal fin and a smaller one on base of pectoral. Base of anal and pelvics tinged yellow.

Material: 3 specimens from Delhi, Z.S.I. Nos. 2044 to 2046; 2 specimens from Assam, Z.S.I. Nos. 1392, 2043 (Day's collections). 12 specimens collected from the Yamuna at Allahabad and Delhi.

Distribution: Type locality: River Ganges. This species has been recorded only from India, where its occurrence is restricted to the upper reaches of the larger river systems of north India, viz. the Ganga, the Yamuna, the Brahmaputra, and the Indus. This is a purely freshwater species. The lowermost point on the Ganga river system where this has been recorded is Patna.

The species does not grow beyond a size of 10 cm.

***Sicamugil hamiltoni* (Day)**

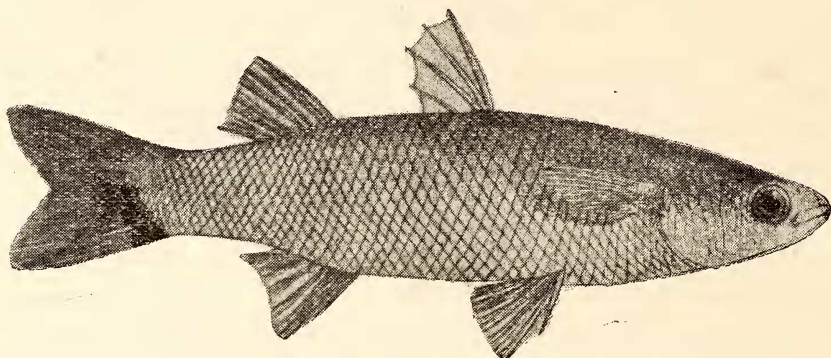
Mugil hamiltoni Day, *Proc. Zool. Soc. London.* p. 614, 1870 (Rivers of Burma) *Fish. India*, p. 354, pl. LXXV, fig. 5, 1878-1888; *Fauna Brit. India, Fishes* 2 p. 349, 1889 (Rivers of Burma).

D. IV, 1 + 8; A. III + 9; V. I + 5; P. 12-14; C. 15; L. 1. 43-47; L. tr. 16-18.

Length of head greater than height of body. Head higher than broad. Length of snout equal to or slightly less than its own height, which is again equal to or slightly less than its width. Diameter of orbit equal to or slightly less than length of snout and distinctly less than the interorbital distance. Insertion of D_1 nearer to base of caudal than to tip of snout. Origin of pelvic fins nearer to origin of anal than to tip of snout. Length of caudal peduncle greater than width and height of head. Least height of caudal peduncle less than width of head. 1st spine of D_1 longer than the 2nd. Insertion of pectoral either in middle of body or very slightly above middle. Caudal fork is deep.

Proportionate measurements: vide Appendix A.

Scales: 43-47 rows on the longitudinal and 16-18 on the transverse series. Pre-dorsal scales 32-34. Elongated scale not present in axil of pectoral. Scales on body are strongly ctenoid.



Text-fig. 3. *Sicamugil hamiltoni* (Day) (After Day, 1878)

Orientation of fins: Insertion of D_1 above 15th-17th, of D_2 above the 27th-29th and of anal below the 23rd-25th L. 1. scales. Pelvic fin inserted below 6th-8th and reaches to the 16th-18th scales. The pectorals reach to the 9th-11th L. 1. scales.

No distinct teeth on lips. Upper lip very thin, forming tip of snout and part of the dorsal profile. Pre-orbital very conspicuous, has a very slight bend and is strongly serrated on the anterior and ventral margins. Extremity distinctly tetra-cuspid. Nostrils of unequal size, the posterior larger. The distance between them is equal to the distance of the anterior from the upper lip and less than that of the posterior from the orbit. Symphysial knob single. No adipose thickening over the eye. End of maxilla hardly visible when mouth is closed. Opercle with one strong spine.

Colour: Silvery, shot with gold, leaden along upper half of body.

Material: 3 specimens from Burma, Z.S.I. cat. Nos. 136 (Sittang), 355, 1401 (from Day's collections).

Remarks: It has not been possible to study fresh specimens of this species. Those in the collections of the Zoological Survey of India were not in a good state of preservation, most of the fins having been damaged. The proportionate measurements, where expressed in relation to total length, and the coloration given here are taken from Day's (1889) descriptions.

Distribution: Type locality: Rivers of Burma.

This species has so far been recorded only from the rivers of Burma where it is a purely freshwater form. The largest size of this species recorded is only 11.5 cm.

Genus *Plicomugil* (Schultz)

Plicomugil Schultz, *U. S. Nat. Mus. Bull.* **202**, pp. 315 and 320, 1953 (genotype, *Mugil labiosus* Cuvier & Valenciennes).

No spine on opercle; lips terminal, with lobes and papillae; nostrils in level with upper rim of orbit; symphyseal knob present; no teeth on jaws. The characteristic feature of this genus is the distinctly lobed (folded) upper lip, which has 2 paired lobes ventral to edge and 4 more at corner of mouth on each side. The lobes are fleshy and fringed with papillae. Front edge of pre-orbital with a conspicuous deep notch into which the lobes of the lip at corner of mouth fit, when mouth is closed. Mouth is protrusible.

Monotypic, *Plicomugil labiosus* (Valenciennes).

Plicomugil labiosus (Valenciennes)

Mugil labiosus Valenciennes, (in Cuvier & Valenciennes), *Hist. Nat. Poiss.*, **11**, p. 125, 1836 (Red Sea); Day, *Fish. India*, p. 357, 1888 (Andamans); *Fauna Brit. India*, *Fishes* **2**, p. 352, 1889 (Andamans).

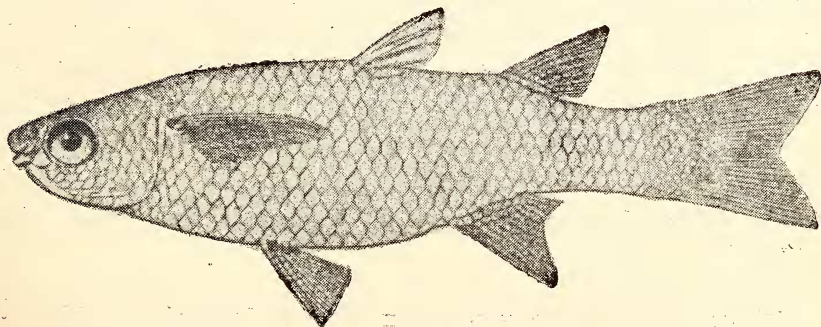
Mugil macrochilus Day, *Proc. Zool. Soc. Lond.*, p. 685, 1870 (Andamans).

Mugil crenilabris Day, *Fish. India*, p. 355, 1888 (Andamans); *Fauna Brit. India*, *Fishes* **2**, p. 350, 1889 (Andamans and Nicobar).

Liza labiosa Fowler, *Copeia*, **58**, p. 62, 1918 (the Philippines).

Liza labiosus Herre, *Mem. Indian Mus.* **13**, p. 347, 1941 (Andamans).

Plicomugil labiosus Schultz, *U.S. Nat. Mus. Bull.*, **202**, pp. 320-322, 1953 (Bikini, Rongelap, Kwajalein Atolls, Romuk and Reer islands, the Philippines, the Red Sea).



Text-fig. 4. *Plicomugil labiosus* (Valenciennes) (After Schultz, 1953)

D. IV, 1 + 8; A. III + 9; V.I + 5; [P.14 - 15; C.14 - 15; L.I. 32-36; L. tr. 10 - 12.

Length of head less than height of body. Head higher than broad. Length of snout less than its height, which in turn is less than the width. Diameter of orbit equal to or slightly greater than length of snout. Diameter of orbit more than half of inter-orbital distance. Insertion of D_1 conspicuously nearer base of caudal than to tip of snout. Origin of pelvic fins nearer origin of anal than to tip of snout. Length of caudal peduncle less than width of head. Length of 1st spine of D_1 exceeds that of the 2nd. Insertion of pectoral above middle of body. Caudal fork not very deep.

Proportionate measurements: vide Appendix A.

Scales: 32 to 36 on the longitudinal and 10 to 12 on the transverse series. 17 to 18 predorsal scales. No elongated scale in axil of pectoral. Bases of all fins except D_1 covered with minute scales. Scales on body ctenoid.

Orientation of fins: Insertion of D_1 above 10th-12th, of D_2 above 23rd-24th, and of anal fin below the 18th-21st scale of the longitudinal series. Pelvic fins inserted below 3rd-5th and reach to 12th-13th; pectorals reach to the 9th-11th L. 1. scales.

Upper lip, forming tip of snout and part of dorsal profile, is broad and fleshy with two folds, the outer overhanging the snout. The outer fold is well folded on itself at the two corners of the mouth. All along the margin of this fold there is a row of short fleshy double papillae. The inner fold is fringed with a row of long fleshy single papillae. Lower lip thin, enlarged and reflected, with a wavy margin and without teeth or papillae. Pre-orbital with a large very conspicuous notch and serrated only on the ventral margin. Nostrils closer to each other than the posterior nostril is to the orbit, the distance of the latter being equal to that of the anterior nostril from the upper lip. The posterior nostril is larger than the anterior, the latter with a raised rim. Adipose eyelids absent. End of maxilla slightly visible when mouth is closed. Symphysial knob present but feeble.

Colour: Olivaceous grey or brown on back, dull white on sides and below. Pectoral with a dark axillary spot.

Remarks: While describing this species for the first time, Valenciennes (Cuvier & Valenciennes, 1836) pointed out its closeness

to *M. crenilabis* Forskål. Day (1870) described *M. macrochilus* Bleeker from the sea off Andaman Islands but later, in his FISHES OF INDIA (1878-1888), considered it a synonym of *M. crenilabis* Forskål and recorded an allied form, *M. labiosus* Valenciennes, also from the Andamans. 2 specimens of *M. labiosus* and one labelled *M. macrochilus*, of Day's collections, were examined by me and it was found that these three specimens were identical in all essential details. Therefore, if, as Day considered, his *M. macrochilus* is synonymous with *M. crenilabis* Forskål, Day's *M. labiosus* will also have to be considered a synonym of *M. crenilabis* Forskål, the latter name getting priority. Most of the descriptions of *M. crenilabis* and *M. labiosus* available are overlapping, the distinguishing points being in the number of L. 1. scales and some vaguely described differences in the morphology of the lips. Schultz (1953), however, has given a clearly defined description of the differences between the two when he separated them under two different genera, *Crenimugil* and *Plicomugil*. The specimens examined by me (Day's *M. labiosus* and *M. macrochilus*) both come under Schultz's (1953) *Plicomugil* and not under his *Crenimugil*. The Indian species is, therefore, the same as *M. labiosus* of Valenciennes, *M. macrochilus* and *M. crenilabis* of Day being its synonyms.

Material: 2 specimens from Andamans—Z.S.I. Nos. 1409, 1410 (*M. labiosus* from Day's collection); 1 specimen Z.S.I. cat No. 353, from Andamans (labelled *M. macrochilus*).

Distribution: Type locality: Red Sea.

In India this species has been recorded only from the Andaman Islands. Its distribution outside India extends to Indonesia, Philippines, Australia, Marshall and Marianas Islands, and the Red Sea.

This species grows to over 40 cm. in length.

(To be continued)

APPENDIX A

Proportionate Body Measurements of Indian species of the
Mugilid genera *Sicamugil* and *Plicomugil*

	<i>Sicamugil cascasia</i>	<i>Sicamugil hamiltoni</i>	<i>Plicomugil labiosus</i>
$\frac{\text{Total length}}{\text{Length of head}}$	4.40-5.00	4.25-5.50	4.50-5.40
$\frac{\text{Standard length}}{\text{Length of head}}$	3.53-3.63	3.50-3.64	3.47-5.00
$\frac{\text{Total length}}{\text{Height of body}}$	4.50-5.25	4.50-5.00	4.33-5.25
$\frac{\text{Standard length}}{\text{Height of body}}$	4.08-4.14	3.77-4.00	3.10-3.28
$\frac{\text{Length of head}}{\text{Diameter of orbit}}$	3.40-4.00	3.50-4.33	3.00-4.00
$\frac{\text{Inter-orbital distance}}{\text{Diameter of eye}}$	1.09-1.37	1.25-1.62	1.51-1.75
$\frac{\text{Length of head}}{\text{Height of head}}$	1.45-1.62	1.56-1.75	1.42-1.58
$\frac{\text{Length of head}}{\text{Width of head}}$	1.60-1.72	1.92-2.00	1.47-1.65
$\frac{\text{Length of head}}{\text{Inter-orbital distance}}$	2.61-3.16	2.66-2.80	1.95-2.11
$\frac{\text{Length of head}}{\text{Length of pectoral fin}}$	1.26-1.36	1.75	1.00-1.05
$\frac{\text{Length of head}}{\text{Length of caudal peduncle}}$	1.60-1.90	1.40-1.66	1.60-1.90
$\frac{\text{Length of head}}{\text{Least height of caudal peduncle}}$	2.50-2.53	2.15-2.40	2.05-2.11
$\frac{\text{Length of caudal peduncle}}{\text{Least height of caudal peduncle}}$	1.33-1.41	1.36-1.60	1.11-1.25
$\frac{\text{Total length}}{\text{Length of caudal fin}}$			5.25-5.50
$\frac{\text{Standard length}}{\text{Snout to } D_1}$	2.20-2.23	1.88-1.91	1.70-1.76
$\frac{\text{Standard length}}{\text{Snout to } D_2}$	1.28-1.32	1.31-1.38	1.23-1.42
$\frac{\text{Standard length}}{\text{Snout to pelvic fin}}$	2.40-2.55	2.37-2.45	2.27-2.47
$\frac{\text{Standard length}}{\text{Snout to anal fin}}$	1.35-1.38	1.32-1.44	1.34-1.41